6.1.1 Zone settling rate test

Zone settling may be observed in the batch settler described by White (1975) and shown schematically in Fig. 6.1. The apparatus consists of a transparent vertical cylinder, in which a batch of sludge is placed. A stirrer is connected to the central axis, which in turn is driven by a low rotation motor, and this gently stirs the sludge.

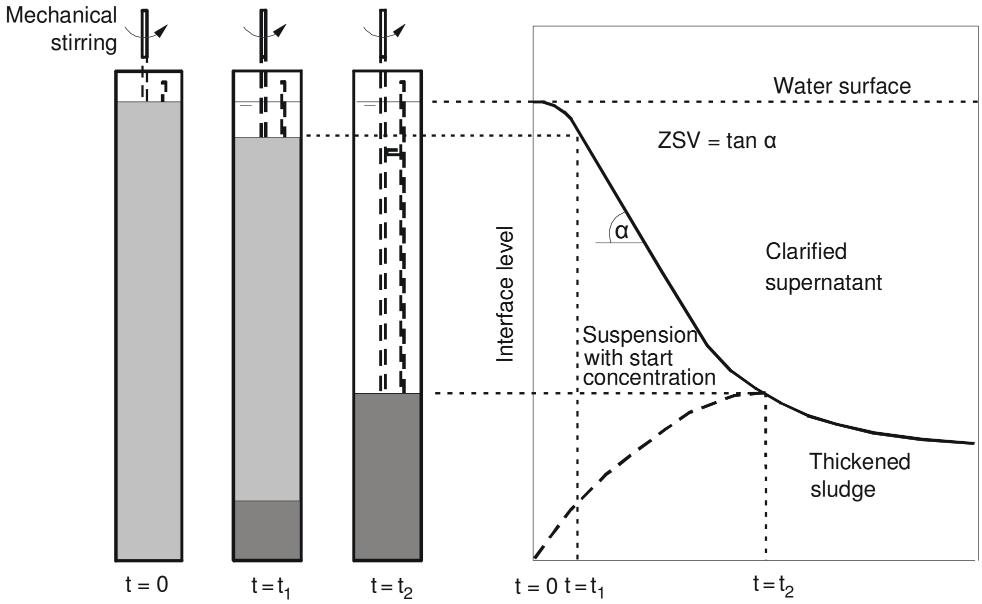

Figure 6.1 Schematic representation of the batch settler used in zone settling experiments (left) and a typical curve of the interface displacement with time (right)

After placing the sludge batch in the cylinder, the following behaviour can be observed:

- A short time (a few minutes) after placing the sludge in the cylinder, a sharp interface is formed, separating the clear supernatant not containing suspended solids in the upper part and settling sludge in the lower part;
- In the region below the interface all sludge particles settle at the same rate, so that the interface is also displaced at the same rate;
- Simultaneously at the bottom of the cylinder, sludge with a higher concentration accumulates. With time, an ever larger fraction of the sludge particles become part of this concentrated sludge;
- After some time, the sludge-supernatant interface approaches the region of concentrated sludge and its rate of displacement starts to decrease gradually.

Fig. 6.l also shows a typical curve of the interface displacement with time. The zone settling velocity is defined as the gradient of the linear (or linearised) part of this curve. Several cylinders may be used in parallel, in order to determine the zone settling velocity simultaneously for different sludge concentrations. The use of different concentrations allows the experimental determination of the relationship between the sludge concentration and the zone settling velocity.

Several research workers have investigated the relationship between the zone settling velocity and the activated sludge concentration. The best known models are those proposed by Vesilind (1968) and by Dick (1972). The models describe the relationship between zone settling velocity and sludge concentration as follows:

(1) Vesilind's equation: $ZSV = v_0 \cdot \exp(-k \cdot X_t)$ (6.1)

(2) Dick's equation: $ZSV = V_0 \cdot (X_t)^K$ (6.2)

Where:

ZSV = zone settling velocity
X = activated sludge concentration
V_0, K, v_0 and k = sludge settleability constants

In order to evaluate which of the two equations better describes the settling behaviour of activated sludge, the following method may be used:

- Obtain experimental data of the zone settling velocity as a function of the sludge concentration;
- Plot this data in a suitable diagram: semi log (natural) for Vesilind's equation and log-log paper for Dick's equation;
- Draw the "best-fit straight line" through the experimental points. The gradient of this straight line will be the constant k (Vesilind) or K (Dick) and the linear coefficient is log v_0 or log V_0.

Smollen and Ekama (1984) analysed their own data from systems in South Africa, as well as that of other activated sludge processes (Pitman, 1980 and 1984; Ibama 1984; Tuntoolavest and Grady, 1980; and Rachwall et al, 1981), and concluded that in all cases Vesilind's equation led to a better description of the actual settling behaviour of activated sludge. These results are corroborated by Catunda et al. (1992) and for this reason Vesilind's equation will be adopted in this text as the basis for the description of activated sludge settling.